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RESEARCH PAPER

Effect of Postharvest Treatments on Shelf Life and Physico-Chemical Properties of Mango cv. Amrapali

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ABSTRACT

The study was carried out to investigate the postharvest treatments effect for enhancing the shelf life of mango. Fully mature uniform size "Amrapali" mango was collected from Satkhira, Bangladesh and was treated with different postharvest treatments viz., T_1: Control, T_2: Neem extract coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5:$Cacl_2$, T_6: Mustard oil coating, T_7: Aloe gel coating. The experiment was conducted in Completely Randomized Design (CRD) with three replications. Results demonstrated that different postharvest treatments significantly ($p \leq 0.05$) influenced the quality and shelf life of mango fruits compared to untreated fruits. The highest firmness (3.77 N), pH (5.34) and TSS (11.63%) were noted from aloe gel coating after 9 days of storage compared to other treatments. In addition, the highest titratable acidity (0.78%), vitamin C (9.38 mg/100g Fw), and shelf life (17 days) and the lowest the disease incidence (26.67%) and disease severity (7.50%) of mango pulp were recorded from garlic extract coating compared to other treatments. So, above results suggest that garlic extract coating could be effectively utilized to extend the shelf life and maintained quality attributes of mango during storage.

Key words: Mango, Quality, Shelf life, Postharvest treatment

Introduction

Mango belongs to the family Anacardiaceae is one of the extensively cultured, traded and popular fruits in Bangladesh as well as in the world. It is one of the most important tropical and sub-tropical fruit of the world and is popular both fresh and processed forms. Among the fruits grown in Bangladesh, mango ranked 5th and 3rd position in case of area and production, respectively. Bangladesh produces 1288315 metric tons of mangoes annually from 102939 acres of land (BBS 2017). Mango has significant amounts of provitamin A, vitamin C, and soluble sugar. In terms of mineral content, mango retains an average place among fruits, and in terms of iron content, unripe mango is first than ripe fruit, roughly the 16th position among all major fruits. The unripe mangoes contain nearly 50% more vitamin C than the ripe ones (Salunkhe and Desai 1984).

Mangoes, one of the climacteric fruits, ripen rapidly after harvest and are easily infected by several postharvest diseases, susceptible to mechanical injuries which lead to considerable postharvest losses, and limit the storage, handling and transport potential of mango fruits. The regular bearing variety Amrapali mango is being cultivated in Bangladesh for its excellent taste and yield. Unfortunately, a remarkable amount of the produce never reaches the consumers due to enormous postharvest losses. In Bangladesh, 25-30% postharvest loss was recorded for mango (Hassan, 2010). Generally, different detrimental chemicals like fungicides and formalin are used to reduce postharvest loss. It is shown that the use of chemical compounds to prolong shelf life and quality, enhance the risk of adding toxic substance with fruits resulting in harmful impact on health and environment (Bose et al., 2020). To overcome this rapid loss of fruits or other foods, natural preservative is a novel food preserving technique which helps in extending the shelf life and enhanced food safety. (Ergun and Satici, 2012). Natural products, such as garlic, chitosan, lemon grass sap, neem extracts, aloe gel etc. are less persistent in environment and are safe for humans and other non-targeted organisms. The fruit's short ripening time seriously restricts its ability to be sold in far-off markets. The mango fruit is poorly suited for long-term storage, and technologies like controlled or modified atmospheres have not been successfully used to this fruit. Fruit postharvest losses have a significant impact on both the economics and population nutrition in underdeveloped nations. To reduce post-harvest losses and increase shelf life of mango, the development of simple technique is essential. Therefore, the current research was conducted to investigate the effect of different preservatives on postharvest quality of mango and to extend the shelf life of mango.

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Materials and Methods

Study location and treatments

The study was conducted at the post-harvest laboratory, Department of Horticulture, Patuakhali Science and Technology University from September 2021 to November 2022. Fully mature uniform size Amrapali mango was collected from Satkhira, Bangladesh at July 2022 and were treated with different treatments viz. T_1: Control, T_2: Neem extracts coating (10%), T_3: Garlic extracts coating (10%), T_4: Lemon grasses extract coating (0.5%), T_5:$Cacl_2$ (5%) T_6: Mustard oil coating (100%), T_7: Aloe gel coating (5%). The experiment was conducted in Completely Randomized Design (CRD) with three replications. To prepare 10% neem extract, 10g crushed neem leaf along with 90 ml water were blended using kitchen blender and then filtered with whattman filter paper no.1. Same procedures were followed in case of 10% garlic extract coating and 5% aloe vera gel coating. To prepare lemon grass extract (0.5%), fresh lemon grass (*Cymbopogon citrates*) was obtained from Horticulture Germplasm Centre, PSTU. Five hundred grams of plant samples was chopped into small pieces and crushed using a mortar and pastel to increase the surface area. Then three hundred grams of the crushed sample was subjected to hydro distillation. The hydro distillation was carried out by using the Clevenger equipment at 20-30°C for 7-8 hours. Finally, 0.5 ml essential extract was mixed with 99.5 ml water. In case of mustard oil coating (100%), mustard oil was purchased from local bazar.

Instrumental procedure

Mango fruit firmness was measured by Digital penetrometer (Stable Micro System Ltd., Surrey UK) along with a measuring probe (5mm diameter stainless steel) and was expressed in Neuton (N). Weight loss % was estimated as [(Initial weight-Final weight)/Initial weight] ×100. This measured by calcu1ating the percentage of fruits infected. The diseased fruits were identified symptomatically. Disease severity represents the percentage diseased portion of infected mango fruit. The infected fruits of each replication of each treatment were selected to determine percent fruit area infected, and were measured based on eye estimation. The pH of mango pulp was determined by using a glass electrode pH meter (GLP 21, Crison, Barcelona, and EEC). The pH meter was calibrated with buffers at pH 4.0 followed by pH 7.0. Titratable acidity (TA) of mango pulp was determined according to the method by Ranganna (1977) and was expressed in percent. Total soluble solid (TSS) content of mango pulp was estimated by using Digital Refractometer (BOECO, Germany) and was expressed in percent. Vitamin C (Ascorbic acid) content was determined according to the method of Ranganna (1979) and was expressed in milligram (mg) per 100 gram of fruit pulp.

Statistical analysis

The collected data were compiled and analyzed by using SPSS 26.0 (IBM, New York, USA) software for calculating ANOVA and the standard error (SE). The significant difference among treatments means were separated by F-test followed by Duncan's Multiple Range Test (DMRT) at 1% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Firmness

Different post-harvest treatments showed significant variation in case of firmness of mango during entire storage period except 6 DAS. At the 3 DAS, the highest firmness (3.63 N) was recorded from treatment T6 while the lowest (2.67 N) was obtained from treatment T_7. At the 6 DAS, the highest firmness (3.33 N) was noted from treatment T6 whereas the lowest (2.17 N) was recorded from treatment T_1. At the 9 DAS, the highest firmness (3.77 N) was observed from treatment T_6 while the lowest (2.23 N) was found from treatment T_3 (**Figure 1**). The fruit's hardness was diminished as a result of ripening and storage related changes and degradation of cell wall components, as well as a decline in fruit integrity (Chiarra and Chitarra 2005). Mustari *et al*. (2020) reported that mango firmness drastically declined as the number of days increased which is almost similar to the present study.

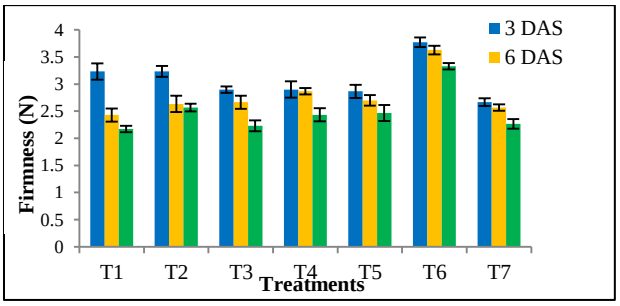

Figure 1: Effect of different post-harvest treatments on firmness of mango during storage.

Vertical bars represent standard error. DAS = Days after storage, T_1: Control, T_2: Neem extract coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5: $CaCl_2$, T_6: Mustard oil coating, T_7: Aloe gel coating.

Weight loss of mango

The weight loss of mango varied significantly due to various post-harvest treatments. At the 3 and 6 DAS, treatment T_2 had the most weight loss of mango (1.89 and 2.75%) while treatment T_3 had the lowest (1.29 and 2.21%). At the 9 DAS, the highest weight loss of mango (3.57%) was marked from treatment T_2, while the lowest (3.29%) was recorded from treatment T_7 (Table 1). Weight loss mainly occurs due to water loss by transpiration and loss of carbon reserves due to respiration (Atlaw 2018). The results of current study showed that there was a rise in weight loss of mango during storage and this findings supported by Hasan (2018).

Moisture content

Significant differences ($P < 0.05$) were noted in respect of moisture content percentage among different postharvest treatments (Table 2). At the 3 DAS, the highest moisture content of mango (83.67%) was noted from treatment T_5 while the lowest (76.00%) was recorded from treatment T_1. At the 6 DAS, the highest moisture content of mango (82.67%) was marked from treatment T_6 whereas the lowest (76.00%) was found from both T_2 and T_7 treatment. The decrease of moisture content was probably due to transpiration and evaporation loss and also due to starch hydrolysis (Atlaw, 2018).

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Table 1: Effect of different postharvest treatments on weight loss and moisture content of mango at different days after storage

Treatments	Weight loss (%) at different DAS			Moisture content (%) at different DAS		
	3	6	9	3	6	9
T_1	1.63^{c}	2.54^{b}	3.29^{c}	76.00b	78.33ab	79.67
T_2	1.89^{a}	2.75^{a}	3.57^{a}	78.33ab	76.00b	78.67
T_3	1.29^{e}	2.21^{c}	3.32^{c}	83.33a	79.33ab	78.67
T_4	1.69^{bc}	2.74^{a}	3.48^{b}	83.00a	76.33b	78.33
T_5	1.63^{c}	2.64^{ab}	3.54^{ab}	83.67a	78.67ab	81.67
T_6	1.52^{d}	2.60^{b}	3.34^{c}	79.00ab	82.67a	82.67
T_7	1.74^{b}	2.74^{a}	3.30^{c}	83.00a	76.00b	77.33
Level of significance	**	**	**	*	*	NS
CV (%)	2.12	1.49	0.87	2.62	2.40	2.42

In column, figures with different letter (s) differ significantly at 1% level probability analyzed by DMRT.
* and ** Significant at 5% and 1% level of probability, NS= Not significant, DAS = Days after storage, T_1: Control, T_2: Neem extract coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5: $CaCl_2$, T_6: Mustard oil coating, T_7: Aloe gel coating.

Shelf life

Treatments used after harvest had a significant impact on how long mango fruits stayed fresh. Mango was found to have the highest shelf life (17 days) at treatment T_3 while the shortest shelf life (9 days) at treatment T_1 (Figure 2).

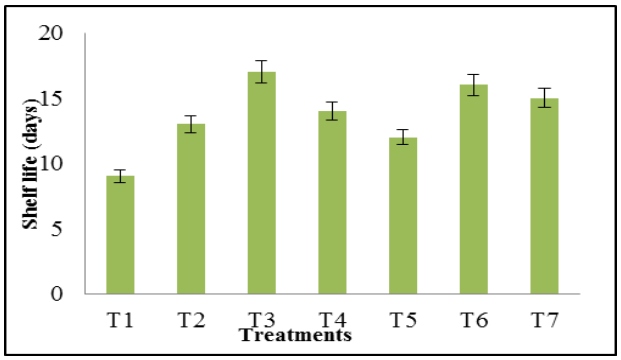

Figure 2: Effect of different post-harvest treatments on shelf life of mango during storage.
Vertical bars represent standard error. T_1: Control, T_2: Neem extract coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5: $CaCl_2$, T_6: Mustard oil coating, T_7: Aloe gel coating.

Similar with our results, Mustari *et al*. (2020) discovered that the shelf life of mango was longest (23 days) at treatment T_6 (Garlic extracts coating) and shortest (12 days) at treatment T_{11} ($CaCl_2$). There is a natural tendency of fruits to degrade to the simpler inorganic compound (CO_2, HO_2, and NH_3) from which they were synthesized in the first place through spontaneous bio-chemical reaction which occur with the decreased in free energy and increase in the randomness of the system, consequently reduce the shelf life as well as other qualities of fruits (Giami and Ali, 1994). So, our results suggest that different postharvest treatments increased shelf life compare to untreated fruits.

Diseases incidence

Mango fruit disease is significantly influenced by temperature and humidity. Among the postharvest treatments, there were significant differences in the frequency of disease occurrence at 9 DAS. Disease occurrence was evident at days 6 and 9 following storage. At the 6 DAS, treatment T_1 had the highest disease incidence 37% while treatments T_2 and T_3 had no disease incidence. At the 9th days of storage, treatment T_5 and T_6 had the highest disease incidence 93.33%, whereas treatment T_3 had the lowest incidence of normal disease 26.67% (**Figure 3**). Mustari *et al*. (2020) reported that mango treated with garlic extract coating remarkably delayed the onset of disease infection, reduced the number of infected fruits and lowered the severity of infection which supported the current study.

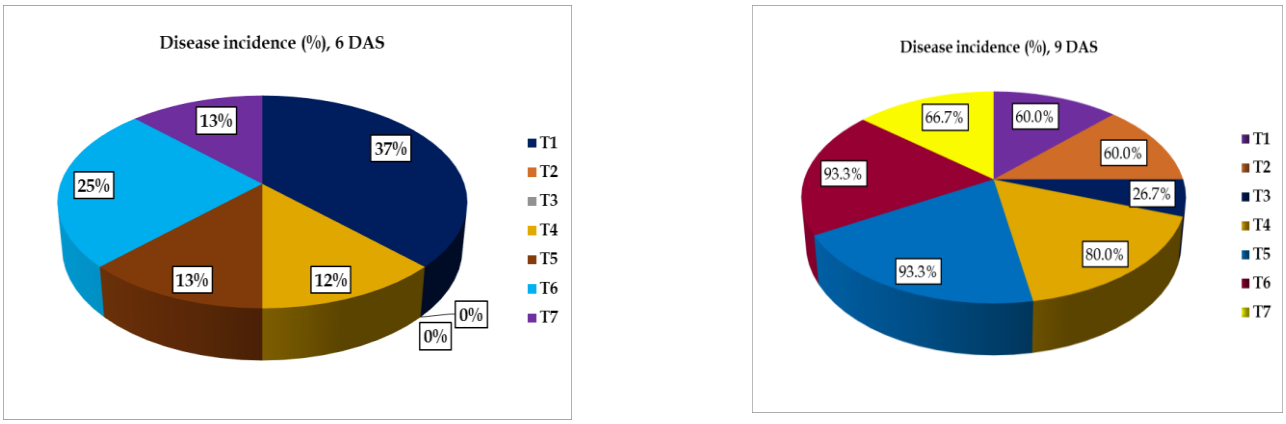

Figure 3: Effect of different post-harvest treatments on disease incidence of mango during storage. DAS = Days after storage, T_1: Control, T_2: Neem extracts coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5: $CaCl_2$, T_6: Mustard oil coating, T_7: Aloe gel coating.

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Diseases severity

At the 6th and the 9th days after storage, postharvest treatments had a significant impact on the levels of disease severity. The disease was mild in cases of T_2 and T_3, and the highest percentage 8.33% was found in treatment T_1 at the 6th DAS. After the 9th DAS, T_1 had the highest disease severity of 50.55%, followed by T_2 (40.14%) whereas T_3 showed the lowest percentage 7.50 % **(Figure 3)**. When compared to untreated fruits, Hofinan *et al*. (1997) found that the treated fruits had a lower incidence of disease which is quite similar to the current study.

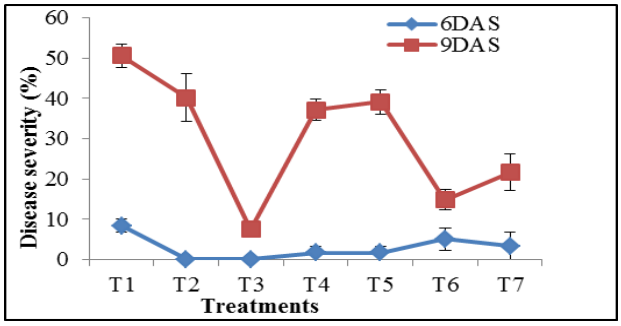

Figure 4: Effect of different post-harvest treatments on severity of mango during storage.

Vertical bars represent standard error. DAS = Days after storage, T_1: Control, T_2: Neem extract coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5: $CaCl_2$ (mango dip in $CaCl_2$ solution), T_6: Mustard oil coating, T_7: Aloe gel coating.

pH

In case of pH, a significant difference was noticed from different treatment during 6th and 9th days of storage (Table 2). At the 6th DAS, the highest pH (5.94) was found from treatment T_7 whereas the lowest (4.16) was observed from treatment T_1 (Table 4). At the 9th DAS, the highest pH (5.34) was marked from treatment T_7 while the lowest (3.81) was recorded from treatment T_6. With the advancement of fruit maturity organic acids concentration are decreases. The organic acids are used in the respiration process during advances of fruit from development to ripening stage and increase the sugar content of fruit resulting enhance pH (Kafkas *et al*., 2007).

Titratable acidity (TA)

In case of TA, highly significant difference was noticed from various treatments during the storage of treated mango (Table 2). At the 3rd DAS, the highest TA of mango (1.05%) was noted from treatment T_3 whereas the lowest (0.21%) was recorded from treatment T_6. At the 6th DAS, the highest TA of mango (0.94%) was recorded from treatment T_3 and the lowest (0.19%) was observed from treatment T_6. At the 9th DAS, the highest TA of mango (0.78%) was found from T_3 treatment while the lowest (0.17%) was marked from treatment T_6. The results showed that there was decrease in TA of mango during storage which supported the findings of Mustari *et al*. (2020) where she reported that titratable acidity of mango drastically declined as the number of days increased. Increased activity of citric acid during ripening or reduction in acidity may be due to their conversion into sugars and their further utilization in the metabolic processes of the fruit (Doreyappa & Huddar, 2001).

Table 2: Effect of different postharvest treatments on pH and titratable acidity of mango at different days after storage

Treatments	pH at different DAS			Titratable acidity (%) at different DAS			% TSS at different DAS		
	3	**6**	**9**	**3**	**6**	**9**	**3**	**6**	**9**
T_1	3.60	4.16c	5.22ab	0.30cd	0.28bc	0.23bc	14.47b	11.50c	11.43a
T_2	3.12	5.53ab	4.94ab	0.44b	0.43b	0.36b	14.47b	12.10b	11.23a
T_3	3.19	5.71ab	4.91ab	1.05a	0.94a	0.78a	9.30c	12.63a	11.40a
T_4	3.17	4.30c	4.96ab	0.35bc	0.33bc	0.31b	9.43c	11.50c	11.40a
T_5	3.20	4.62bc	4.45bc	0.39bc	0.37b	0.33b	8.47d	12.03b	11.13a
T_6	3.51	4.62bc	3.81c	0.21d	0.19c	0.17c	7.97d	10.83d	10.23b
T_7	3.22	5.94a	5.34a	0.37bc	0.36b	0.33b	15.63a	12.07b	11.63a
Level of significance	NS	**	**	**	**	**	**	**	*
CV (%)	5.15	8.68	6.74	8.45	9.82	9.49	2.74	1.84	2.71

In column, figures with different letter (s) differ significantly at 1% level probability analyzed by DMRT.

* and ** Significant at 5% and 1% level of probability, NS= Not significant, DAS = Days after storage, T_1: Control, T_2: Neem extract coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5: $CaCl_2$, T_6: Mustard oil coating, T_7: Aloe gel coating.

Total Soluble Solids (TSS)

TSS content of mango showed highly significant variation among different postharvest treatments. At the 3rd DAS, treatment T_7 showed the highest TSS (15.63%) while treatment T_6 had the lowest (7.97%). At the 6 DAS, treatment T_3 had the highest TSS (12.63%) whereas treatment T_6 had the lowest (10.83%). The maximum TSS (11.63%) was recorded from treatment T_7 while the minimum TSS (10.23%) from treatment T_6 were recorded at 9 DAS (Table 2). The increasing trend of percent total soluble solids contents of fruit during storage could be attributed mainly to the breakdown of starch into simple sugars. This observation is somewhat similar to Pinaki *et al*. (1997). They discovered that treated and untreated mangoes varied significantly in taste and appearance, and the treated fruit had a greater TSS content.

Vitamin C

Highly significant difference was observed among the different treatments in respect of vitamin C content of mango fruits. At the 3, 6 and 9 DAS, the highest vitamin C content of mango (20.5 mg/100g Fw, 10.42 mg/100g Fw and 9.38 mg/100g Fw) was observed from treatment T_3 followed by T_1 (19.66 mg/100 g Fw, 10.07 mg/100g

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Fw and 9.03 mg/100g Fw) whereas the lowest (11.11 mg/100g Fw, 7.29 mg/100g Fw and 5.90 mg/100g Fw) was found from treatment T_4, respectively (Figure 5). The decrease of vitamin C during storage might be due to the rapid conversion of L-ascorbic acid in to dehydro-ascorbic acid in presence of enzyme ascorbinase (Mapson 1970) which is further consumed during metabolic process of the fruits. Mustari *et al*. (2020) reported that vitamin C content of mango drastically declined as the number of days increased which somewhat similar to the results of the current study.

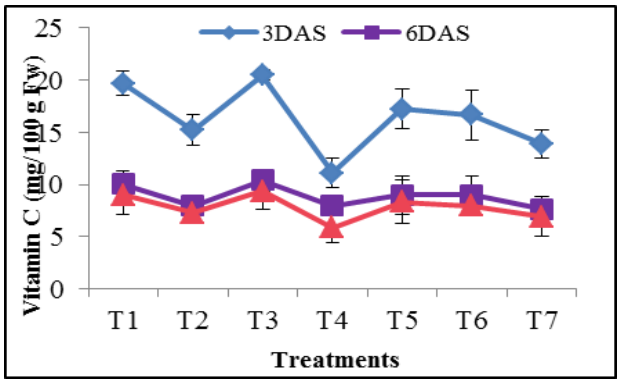

Figure 5: Effect of different post-harvest treatments on vitamin C of mango during storage.
Vertical bars represent standard error. DAS = Days after storage, T_1: Control, T_2: Neem extract coating, T_3: Garlic extract coating, T_4: Lemon grass extract coating, T_5: Cacl2, T_6: Mustard oil coating, T_7: Aloe gel coating.

Conclusion

The findings of the present study demonstrate that different postharvest treatment had a gainful impact on the retention of mango fruit quality during storage. Among the postharvest treatments, garlic extract coating delayed the disease incidence and disease severity resulting increased the shelf life of mango during storage. In addition, garlic extract coating preserves higher levels of vitamin C, TSS and pH during storage of mango. From above findings, it can be concluded that different postharvest treatments could be used as environment-friendly compounds and partial substitution of chemical fungicides to maintain mango fruit quality during storage. Finally, it can be suggested that mango fruit treated with garlic extract coating and aloe gel coating are promising for long term storage and maintaining quality of mango.

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